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DEPARTMENT OF PHYSICS AND GEOPHYSICAL SCIENCES
SCHOOL OF SCIENCES AND HEALTH PROFESSIONS
OLD DOMINION UNIVERSITY
NORFOLK, VIRGINIA

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AEROSOL STUDIES

By

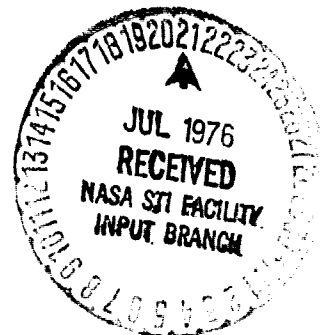
Franklin S. Harris, Jr.

Final Report
1 November 1972 - 30 October 1975

Prepared for the
National Aeronautics and Space Administration
Langley Research Center
Hampton, Virginia

Under
Research Grant NGR 47-003-068

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Kenneth H. Crumbly, Technical Monitor
Instrument Research Division



Submitted by the

Old Dominion University Research Foundation
Norfolk, Virginia 23508

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Franklin S. Harris, Jr.¹

INTRODUCTION

The purpose of this grant was to pursue experimental and theoretical studies on aerosols in which the various methods of measuring aerosols were to be studied in terms of the best methods to be used, the instruments or techniques actually employed, and those techniques applied in field measurements on air quality as influenced by rocket launch effluents, and in an urban environment. Further studies were to be initiated on the remote sensing of aerosols by satellites and the influence of aerosols on visibility. The characterization of aerosols by measurement of scattered light was to be studied on Mie theory calculations. All this work was to be carried out in close cooperation and interaction with the personnel of the Aerosol Measurements Research Branch (AMRB) of NASA-Langley Research Center (LaRC).

I. AEROSOL MEASUREMENT TECHNIQUES

The development of improved measurement techniques at LaRC AMRB is the result of the complete team effort of the aerosol group of that branch, but in which this author participated in discussions, planning, recommending instruments, discussions with leaders in the aerosol discipline in the United States and abroad, both at their research facilities and at meetings, making measurements, the evaluation of data, and interpretation of results. Much of this has been

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1

incorporated in reports and articles on the six field measurement programs, three at Cape Kennedy, and three in Norfolk, Virginia, authored by various members of the team. Those already published in which this author was listed as a co-author are given in the references. The measurements in Chesapeake, Virginia of air quality, which was direct responsibility of this grant, has the report in preparation. A bibliographic study of the characterization of aerosols has been published and favorably received.

II. OPTICAL TECHNIQUES

A comprehensive bibliography on the applications of lasers to atmospheric sciences was prepared and published. The interactions of aerosols with light, in which the aerosols leave their nature on the scattered light, has been studied theoretically and results presented at various meetings. The more ready availability of these results in report and article form in journals has not yet been completed. It includes: the effect of size distribution and complex refractive index on the angular distribution of the various polarization parameters of the scattered light; the predicted variation in scattering by experimentally derived size distribution variations of three different research groups; the effect of combining two different aerosol materials and size distributions, the first results of which were completed under this grant. Some of the latter may have application to remote sensing measurements. The problem of visibility in a fog, its measurements, and the correlation of measurements with predictions was given some attention. The lists of presentations and publications are attached.

During the period of this grant, attention has been given to a wide variety of the characteristics of aerosols, their measurement, and effects of their presence under a wide variety of conditions, from Nimbus G, to effects on climate, to their production by rocket launches, to air quality in urban environments, to visibility, and the determination of the characteristics by measurements of scattering of light. This has included theoretical computer calculations, systems analysis, field measurements, and instrumental analysis, together with interpretation and presentation of data. Contributions have been made to the advancement of knowledge in all these areas.

PRESENTATIONS AT SOCIETY MEETINGS OR SEMINARS

Furman University
University of Rochester
University of Missouri (Rolla)
University of Mainz (Germany)
Air Pollution Control Association
Fourth Commonwealth Pollution Control Workshop
National Bureau of Standards
Environmental Protection Agency, Region III (Philadelphia)
Virginia State Air Pollution Control Board, Region VI
Fraunhofer Gesellschaft (Grafschaft, Germany)
NASA-LaRC Atmospheric Sciences Seminar
NASA-LaRC Shuttle Effluents Review
Ruhr University (Bochum, Germany)
International Commission for Optics
Society for Aerosol Research
Optical Society of America (3)
American Chemical Society

INVITED MEMBER OF WORKING GROUP

Climatic Impact Assessment Program (Denver)
Institute for Defense Analysis
Optical Society of America (organized session of Measurement of
Optical Properties from Space)

PUBLICATIONS

1. "Predicted Scattering from Measured Aerosol Size Distributions Using a Six-Component Log-Gaussian Model". J. Opt. Soc. Am., 62, 1367 (1972) (with M.P. McCormick).
2. "Calculated Mie Scattering Properties in the Visible and Infrared of Measured Los Angeles Aerosol Size Distributions". Appl. Opt., 11, 2697-2705 (1972).
3. "Prediction of Aerosol Size Distribution and Refractive Index from Scattering Measurements". J. Opt. Soc. Am., 63, 491 (1973) (with M.P. McCormick).
4. "Atmospheric Optics". Optical Industry and Systems Directory, Encyclopedia Dictionary. Optical Publishing Co., Pittsfield, MA, ed. 21 (1974), pp. E4-E6.
5. "Optical Scattering Characteristics of Aerosols". International Symposium on the Chemistry of Sea/Air Particulate Exchange Processes, Nice, France, 4-10 October 1973, p. B3.
6. "Effluent Sampling of Scout "D" and Delta Launch Vehicle Exhausts". NASA TM X-2987, 69 pages, July 1974 (with William C. Hulten, Richard W. Storey, and Gerald L. Gregory).
7. "Atmospheric Particulate Measurements in Norfolk, Virginia". NASA TM X-3285, 19 pages, December 1975 (with Richard W. Storey, Jr., Ronald J. Sentell, David C. Woods, and John R. Smith).
8. "Lorenz-Mie Scattering for a Mixture of Two Aerosol Size Distributions". J. Opt. Soc. Am., 64, 540 (1974) (with M.P. McCormick).
9. "Symposium on Optical Aspects of Oceanography, Copenhagen, 19-23 June 1972". Appl. Opt., 13, 1538-1539 (1974).
10. "Fifth Conference on Laser Radar Studies of the Atmosphere, Williamsburg, VA, 4-6 June 1973". Appl. Opt., 13, 1990 (1974), also in Raman Newsletter.
11. "Atmospheric Optics, 25 April 1974". Appl. Opt., 13, 1990 (1974).
12. "Visibility Sensors". In Edward A. Wolff and Enrico P. Mercanti (eds.), Geoscience Instrumentation, John Wiley and Sons, New York (1974), pp. 518-519.

13. "Aerosol Characteristics of Polarized Light Scattering". American Chemical Society, 167th National Meeting, Los Angeles, CA, 1-5 April 1974, Abstracts of Papers, Colloid and Surface Chemistry, No. 5.
14. "Scattering Properties of Aerosols". Jahreskongress 1974 der Gesellschaft für Aerosolforschung, Bad Soden, Germany (1975), 6 pages.
15. "Gesellschaft für Aerosolforschung Jahreskongress 1974, Aerosols in Natural Science, Medicine, and Technology, Bad Soden, 16-19 October 1974". Appl. Opt., 14, 2557-2558 (1975).
16. "Laser Applications to Atmospheric Sciences--A Bibliography". NASA CR-2536, June 1975, 134 p.
17. "Atmospheric Aerosols: A Literature Summary of Their Physical Characteristics and Chemical Composition". NASA CR-2626, January 1976, 43 p.
18. "Determination of Atmospheric Aerosol Characteristics from the Polarization of Scattered Radiation". Fifth Conference on Laser Radar Studies of the Atmosphere, Williamsburg, VA, 4-6 June 1973, Conference Abstracts, pp. 15-16 (with M.P. McCormick).